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Federal Communications Commission
Office of the Secretary

In the matter of	)	
	)	
Advanced Television Systems and	)	
Their Impact on the Existing	)	**MM Docket No. 87-268**
Television Broadcast Service	)	

REPLY COMMENTS
of the
DAVID SARNOFF RESEARCH CENTER, INC.
on the
NOTICE OF INQUIRY

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PREFACE

The David Sarnoff Research Center hereby submits Reply Comments related to the Notice of Inquiry in MM Docket No. 87-268, released August 20, 1987. By this proceeding, the Commission seeks input on 1) advanced television systems and their impact on the existing broadcast service; 2) a review of technical and operational requirements, Part 73-E, television broadcast stations; and 3) a reevaluation of the UHF television channel and distance separation requirements of Part 73 of the Commission's Rules.

Comments of the David Sarnoff Research Center, filed November 18, 1987, addressed each of these matters and indicated support of the Commission's initiative to examine high-definition television systems while urging caution in any plan to modify the present allocation of frequencies, as shown in the Commission's Rule Section 2.106.

The David Sarnoff Research Center acknowledges the many favorable references to its Advanced Compatible Television (ACTV) system in Comments in this proceeding filed by authors who have seen ACTV demonstrated or heard it described. The receiver-compatible transmission of wide aspect ratio, improved resolution images within a single 6-MHz channel seemed particularly attractive to these commenters. An added feature of ACTV is that it can be extended to full HDTV in a reverse-compatible manner* by using additional bandwidth as soon as spectrum space and display technology make this option practical.

The David Sarnoff Research Center also noted that some commenters have an incomplete understanding of the ACTV system. Misconceptions about ACTV typically involve two false suppositions: 1) that adoption of the ACTV system would somehow slow the advent of full HDTV in the U.S. or 2) that the ACTV system will never be capable of delivering full HDTV. There were also occasional claims for other systems that appear to be inaccurate or misleading. These troublesome claims typically make assertions regarding performance, flexibility, cost, and "de

* Reverse compatibility in this text means that television receivers in the hands of the public at the time any extensions of the ACTV system are introduced, will continue to provide television images and sound of at least as good quality as prior to such extensions.

facto standard" that are unwarranted at this time. The main purpose of these Reply Comments is to address all of these misunderstandings as well as other issues that were raised less commonly in the comments on the Inquiry.

REVIEW OF THE ACTV SYSTEM

Technical details of the ACTV system were presented in the body and Appendix of the David Sarnoff Research Center's original comments on the FCC's Inquiry and will not be repeated here. It is appropriate, however, to re-emphasize certain aspects of the system and its supporting arguments that are germane to these Reply Comments.

ACTV can be introduced in a single 6-MHz channel in a receiver-compatible manner. As such, it offers 5X3 (or 16X9) aspect ratio with improved horizontal and vertical resolution. This introductory system, called ACTV-I, is not full HDTV, but consumers will notice that picture quality has been improved dramatically over NTSC. In order to include this increased information within the same TV channel bandwidth, a new subcarrier has been introduced, the low frequency content of the edges of the wider picture has been compressed into the receiver's overscan region, and the picture carrier has been quadrature-modulated with additional detail information.

Each of these processes can, in principle, create artifacts in non-ACTV (i.e., standard NTSC) receivers. It has been the purpose of research at the David Sarnoff Research Center to reduce these artifacts to virtual invisibility. Success in this regard has been commented upon favorably by others who have seen ACTV demonstrations. The effects on "old" receivers of the introduction of ACTV will be even less noticeable than the introduction of compatible color was on then-existing black and white receivers.

In fact, it is likely that the net effect of the ACTV signal on old receivers will be an improvement in the (normal aspect ratio) picture presented. This is because the ACTV system includes pre-processing at the studio and transmitting station which

reduces some of the existing NTSC artifacts. Since these existing artifacts are more visible than the new ones which ACTV can create, their reduction offers an opportunity for improved NTSC for all viewers coincident with the introduction of ACTV for viewers with new receivers.

Thus far, ACTV has been demonstrated with computer simulations. Included in the studies have been simulations of RF transmission path effects, such as noise and multipath. Capability and experience with such RF-domain simulations have existed at the David Sarnoff Research Center for some years, and so there is confidence that real-world tests will provide a minimum number of surprises. ACTV receiver and signal generation hardware is under construction, with expectation of real-time studies in the very near future. A hardware test bed for ACTV transmission path effects is in place. When the time is appropriate and with the Commission's approval, the ACTV system will be tested with over-air transmissions. We suggest that an industry-wide cooperative study would be appropriate.

The introductory ACTV-I signal can be augmented to provide full HDTV quality by using additional bandwidth. For convenience, this augmented system is designated ACTV-II. The additional bandwidth need not be contiguous with the main channel and is not necessarily 6 MHz wide. It can include picture resolution improvement as well as digital audio channels. Results of early augmentation studies indicate that it is likely that an augmented ACTV signal can produce better picture quality than that shown in the demonstrations of 8.1-MHz MUSE; the resolution of moving pictures can be superior while still picture resolution can be equivalent. This ACTV-II signal is fully reverse-compatible with ACTV-I receivers as well as with "old" NTSC receivers. In common with other 2-channel proposals, the effects of different interference, noise, and multipath from the main signal must be studied. The David Sarnoff Research Center has placed a high priority on presenting a demonstration of ACTV-II as soon as possible.

The above 2-step scenario for the introduction and augmentation of ACTV presents several advantages when compared with the introduction requirements for other systems. ACTV-I offers the opportunity to improve TV pictures <u>now</u>. There is no need to wait for bright, high resolution picture tube technology or for a study of the UHF taboos to show how bandwidth can be released for improved TV. The step to

ACTV-II offers the opportunity for full HDTV at the earliest possible time that the economics of picture tubes, the performance of UHF tuners actually in consumers' homes, and the studies of interference effects on wide-band HDTV signals all coincide sensibly. The 2-step scenario offers the optimum match to the availability of displays and spectrum, and it continues to do this as their availability improves with time.

An advanced TV system should be deliverable by all media, including broadcast, satellite, cable, tape, disk, etc. A single system maximizes the volume of receivers and associated products, minimizes consumer cost, and eliminates confusion in interconnections and equipment compatibility. The purveyors of different media have legitimate concerns that a new single standard may be optimized for only one medium and that their delivered signal may suffer in comparison. The David Sarnoff Research Center intends to demonstrate that ACTV answers these concerns and is deliverable in equivalent quality with full compatibility by all media. There is no need for a plethora of systems.

ACTV serves well all segments of the American viewing public. A fully receiver-compatible system means that all advanced TV programming will also be accessible to viewers with conventional NTSC receivers.

THE MUSE SYSTEM

Since MUSE was mentioned so frequently in various comments on the Inquiry, it is appropriate to discuss that system in these Reply Comments.

The developers of MUSE deserve great credit for focusing the world's attention on HDTV with their dramatic demonstrations of improved picture quality. Their proposal for turning full HDTV into a signal with lower bandwidth gave the first hopes of a practical distribution system. They also demonstrated an example of the trade-offs that are necessary when a signal's bandwidth is reduced.

Important though these contributions may be, neither they nor subsequent modifications of the MUSE system make the MUSE picture equivalent to true HDTV

or even suggest that it is a suitable benchmark against which other systems should be judged. In like manner, though some of the MUSE demonstrations have included terrestrial and satellite transmission, they do not constitute rigorous tests nor do they establish that the system is operational under less well-controlled noise and multipath conditions. MUSE has become a growing family of different standards in different bandwidths with different performance levels and different degrees of "compatibility." In citing the performance of "MUSE," it is not appropriate to collect the best attributes of each member of the family.

Contrary to assertions in some of the comments on the Inquiry, the MUSE family is not the only route to advanced or high-definition TV. Neither is it true that systems that are receiver-compatible are necessarily limited to lower picture quality or higher cost or complexity than MUSE. Appropriate processing of the NTSC signal before broadcast and appropriate processing of the received signal in the home can be combined with an advanced but compatible signal format to deliver advanced and high-definition TV at reasonable cost without sacrificing receiver-compatibility.

MUSE is sometimes portrayed as a "de facto standard." This is not appropriate. For example, a standard based on progressive scan offers many signal processing advantages over the interlaced standard on which MUSE is based. For the U.S., a standard based on 525 or 1050 lines would make more sense than one derived from 1125 lines.

Some of the Comments in the Inquiry overstated the amount of ancillary development associated with the MUSE system. There is no "vast archive" of HDTV program material that exists in a format unique to the 1125-line systems. For example, film libraries could be delivered just as well by standards based on 525 or 1050 lines. While equipment is available to support 1125-line production systems (and was used by the David Sarnoff Research Center in its studies and demonstrations of ACTV), its existence in limited quantities merely shows its technical feasibility (and, incidentally, the feasibility of some of the other alternatives mentioned above) and does not constitute a de facto standard. More important than any of the above, however, is the fact that there is no direct-view, consumer-priced, HDTV picture tube that has acceptable brightness and contrast. Without this important piece of equipment, the development of advanced TV will be

slowed unless a more evolutionary approach, such as that described for ACTV, is adopted.

The MUSE family is not receiver-compatible. The fact that converter boxes could be designed to make a conventional picture out of a MUSE signal does not constitute receiver-compatibility. Such boxes will likely be costly and will certainly be inconvenient for much of the viewing public. The fact that a MUSE signal could be sent *in addition to* conventional NTSC does not constitute compatibility either. Assuming an 8.1-MHz MUSE signal, nearly 2 1/2 times the bandwidth of a current TV channel would be required to achieve "compatibility" by this means. Such spectrum is not immediately available, and the wisdom of its allocation in the face of alternatives such as ACTV is certainly questionable. The fact that low-performance versions of MUSE might be designed to be receiver-compatible does not change the basic truth that attainment of HDTV via the MUSE family will disenfranchise owners of NTSC receivers unless they buy converter boxes or unless completely new spectrum is found in which to transmit the 8.1-MHz "HDTV" MUSE signal. Based on the observed life of today's TV receivers and faced with an example of the continuing sales of black and white receivers, the NTSC system must be supported for at least two decades in the future. Burdened with maintaining compatibility over so long a period, MUSE would likely delay the availability of HDTV to broadcasters and their viewing public. ACTV, which includes receiver-compatibility as a fundamental tenet of system acceptability, is a better alternative.

CONCLUSIONS

Because the complete ACTV system is reverse-compatible at every step, it offers the path to HDTV that is fastest, least costly, and least confusing to the consumer. Because of cost, compatibility, and phased introduction, it is the most practical approach in the business sense. Because of its performance and its flexibility in matching the introduction times with developing technologies, it makes the most technical sense. Because of its visible improvement and reverse-compatibility, it provides the most rapid means of introducing advanced television to American

homes. Because it has the potential to improve the presentation on "old" NTSC receivers, it could benefit even those homes without ACTV receivers.

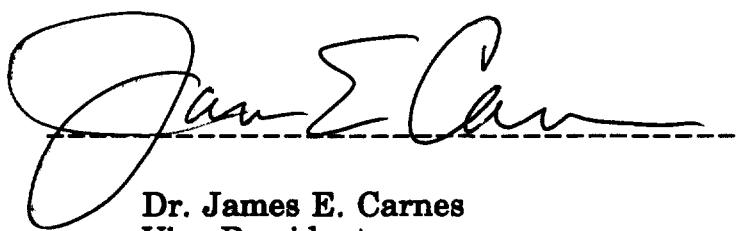
Demonstrations of ACTV have been based on computer simulations. While the experience on which those simulations are based gives high confidence of their accuracy, the David Sarnoff Research Center is building hardware prototypes of both studio signal generation and home receiver equipment to be used for tests of transmission effects. The David Sarnoff Research Center is also committed to a demonstration of the ACTV-II augmentation system at the earliest possible date. ACTV will be ready for test in a timely fashion and can allow earliest possible delivery of advanced TV to American homes.

The benefits of ACTV, as described above, are so compelling that the ACTV system *must* be considered for delivery of advanced television in the United States. The David Sarnoff Research Center strongly urges the Commission to ensure that ACTV is included in and fairly evaluated by the tests that will be conducted by the Commission's Advisory Comittee on Advanced Television Service.

Respectfully submitted,

David Sarnoff Research Center, Inc.

by:



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